63-3-1

PRODUCTION ENGINEERING MEASURE
RELIABILITY IMPROVEMENT
JET ETCH TRANSISTOR

THIRD QUARTERLY REPORT

PERIOD: OCTOBER 31, 1962 - JANUARY 31, 1963

TO

U. S. ARMY ELECTRONICS MATERIEL AGENCY

PHILADELPHIA, PENNSYLVANIA

CONTRACT NO. DA-36-039-SC-86721
ORDER NO. 19043-PP-62-81-81

SPRAGUE ELECTRIC COMPANY
NORTH ADAMS, MASSACHUSETTS

PRODUCTION ENGINEERING MEASURE

RELIABILITY IMPROVEMENT

JET ETCH TRANSISTOR

Third Quarterly Report

Period: October 31, 1962 - January 31, 1963

Object of Study: To improve production techniques to increase the reliability of the jet etch transistor Type 2N1500.

Contract No. DA-36-039-SC-86721
Order No. 19043-PP-62-81-81

Controlling Specifications:

Signal Corps Industrial Preparedness Procurement Requirements No. 15, 1 October 1958
Specification MIL-STD-129C, 11 July 1960, with Change Notice 1, 10 February 1961, and Addendum No. 1, 3 May 1961
Specification MIL-P-11268D (SigC), 26 September 1958
Specification MIL-I-45208 (Army), 26 December 1960

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SECTION 1

ABSTRACT

Progress toward development of an automatic collector delineation process is described herein. A new measuring device, more sensitive than the previous one, is now in use and has isolated the remaining two major problems. These are contact resistance and asymmetrical flow of the jet stream. Work to solve these problems is described.

Preliminary results of an investigation of two new potting compounds which may engender an improvement in power dissipation are reported.

Four methods of measuring the thermal transfer factor (θ) were investigated. A discussion is included in this report.

The status of the program, life test results to date, and current failure rates are also presented.

SECTION 2

PURPOSE

The purpose of this contract is as follows:

(1) To provide the engineering for improvement of production techniques to increase the reliability of the jet etch transistor Type 2N1500 toward the objective of a maximum operating failure rate of 0.01% per 1000 hours at 90% confidence.

(2) Specifically, to improve the following processes:

(a) Plating of gold ring
(b) Emitter pit contour
(c) Collector pit contour
(d) Pit plating
(e) Emitter and collector lead attaching
(f) Collector delineation

and, as a result of first quarter engineering experiments and life tests, to carry out the following added projects in order to:

(g) Establish the optimum resistivity and thickness of the P-type bulk material.

(h) Establish the optimum N-type diffusion gradient.

(i) Establish the optimum emitter placement within this gradient in order to increase the physical base to the maximum allowable thickness without causing any detrimental effects to any parameters.

(3) To produce and deliver 48 engineering sample units at times defined under the contract.

(4) To prepare an inspection and quality control manual prior to the production run.

(5) To perform a production-type run of units on authorization from the U. S. Army Electronics Materiel Agency.

(6) To provide quarterly reports.

(7) To prepare production engineering measure final reports in accordance with Step II of SCIPPR No. 15, Paragraph 3.8.

SECTION 3

NARRATIVE AND DATA

3.1 General

During the third quarterly reporting period work was directed toward improving the manufacturing process, improving the power dissipation of the transistor, and investigating a method for predicting power dissipation. Specifically, the following tasks were performed:

(1) The writing of manufacturing specifications.
(2) The writing of process control specifications.
(3) A continuation of the study of the delineation process.
(4) A study of various potting compounds and their effects on power dissipation.
(5) An investigation of the possibility of manufacturing a test set which measured thermal transfer factor (θ) rapidly.

In addition, investigations were carried out on the reliabilities of punch through limited units and diode limited units.

Details of work in these areas are provided in this section.

3.2 Manufacturing Specifications

A list of the manufacturing specifications for jet etch transistor, diffused collector, Type 2N1500, are given in Figure 1.

3.3 Process Control Specifications

A list of the process control specifications for jet etch transistor, diffused collector, Type 2N1500, are given in Figure 2.

FIGURE 1

LIST OF MANUFACTURING SPECIFICATIONS

Item	Specification Number
General process specification	1-0-000-0015
Materials	
General process specification for germanium preparation	1-0-000-0007
Index tab	51-0307-01
Tab cleaning	1-1-000-0014
Stems	51-0504-01
Emitter wire	51-0209-01
Collector wire	51-0206-01
Wire cleaning	1-1-000-0017
Spool cleaning	1-1-000-0094
Potting compound	50-[illegible]4-01
Topshield filling (automatic)	1-1-000-0083
Topshields	52-0104-04
Topshield cleaning	1-1-000-0015
Fabrication	
Mount tab in carrier	1-2-000-0075
Solder blank to tab	1-2-000-0065
Plating solution	1-1-000-0098
Rough etch solution	1-1-000-0165
Finish etch solution	1-1-000-0097
Etching and plating conditions	36-02-10-017
Emitter lead attaching	1-2-000-0066
Emitter plating solution	1-1-000-0175
Collector lead attaching	1-2-000-0067
Collector plating solution	1-1-000-0175
Rinsing and drying transistors	1-2-000-0068
Rinsing solution	1-1-000-0040

FIGURE 1 - page 2

LIST OF MANUFACTURING SPECIFICATIONS

Item	Specification Numbers
Fabrication	
Operation of delineation etch console	1-2-000-0143
Delineation etch solution	1-1-000-0172
Delineation etch operating conditions	36-02-10-017
Operation of rinse wheel	1-2-000-0071
Delineation check	1-3-000-0080
Tab weld and shearing	1-2-000-0081
Emitter and collector wire welding	1-2-000-0082
Poly dipping	1-2-000-0142
Vacuum baking	1-2-000-0030
Dry box operation	1-2-000-0060
Encapsulation	1-2-000-0017
Final Processing	
Hermetic seal test	1-3-000-0017
Hermetic seal test solution	1-1-000-0141
Temperature cycling	1-2-000-0062
Preconditioning	1-2-000-0063

FIGURE 2

LIST OF PROCESS CONTROL SPECIFICATIONS

Item	Number
Blank-to-tab alloy test	1-3-000-0013
ECDC parameter control inspection	1-3-000-0087
Germanium process control final inspection	1-3-000-0084
Post-seal inspection	1-3-000-0085
Process control mechanical inspection	1-3-000-0086
Process control metallurgical inspection	1-3-000-0088

3.4 Collector Delineation

As reported in the Second Quarterly Report, two of the problems associated with the development of an automatic collector delineation process are the construction of a monitoring device with sufficient precision to control the etching of the individual units and the selection of a parameter for this monitoring device to measure. After experimentation with various parameters, the reverse collector voltage at a fixed current level, V_{CB}, was found the most suitable for measurement in this application.

The method of etching automatically is as follows: The unit is delineated initially with a timed-etch method used to determine the period of delineation. Then a measuring circuit applies the necessary conditions. If V_{CB} rises to an empirically determined value, the measuring circuit automatically ends the delineation cycle. However, if V_{CB} remains under the value, a second, shorter timed etch is applied and the unit remeasured. This sequence continues until the measuring circuit determines that the unit is properly delineated.

During this quarter, work was concentrated on constructing a more sensitive device for measuring V_{CB}. This new detector is now in use and has uncovered several problems which went undetected by the relatively insensitive device formerly in use.

The two major problems remaining are contact resistance and jet stream flow pattern. The more serious of these is contact resistance between the collector lead and the tweezer arms which provide electrical contact to the lead during the etching process. This problem is now being approached in the following manner:

A voltage probe which will make contact for the high-impedance sensing device and thus bypass the contact resistance and a design of a new contact for biasing are being developed. Anticipation is high that these devices will solve the contact resistance problem.

The second problem, asymmetrical flow of the jet stream is impossible to eliminate with existing equipment but has been minimized so that it may possibly not have an adverse effect on measuring V_{CB}. However, if the flow pattern proves troublesome in the future, major modifications of the etching equipment will be required.

Other work on the delineation process consists of the following:

(1) Several minor circuit modifications are being made at the delineation stations.

(2) Two methods of measuring the etch time are under development. One method utilizes the changes in C_{ob} by two orders of magnitude between the delineated and the undelineated state. The other involves measuring resistance of the material between collector and emitter and then translating the measurement to a timed etch. One of these two methods would be used if for some reason, not evident at the present time, the V_{CB} system proved impractical.

It appears the collector delineation problem is near solution. Final work on this step is expected to be performed during the fourth quarter.

3.5 Potting Compound Investigation

It has been shown that the reliability of the Type 2N1500 transistor can be increased by operating the PN junction at the lowest possible temperature at rated power. Theoretical thermal resistance calculations have shown that the most expedient method of decreasing the junction temperature at rated operating power is to increase the thermal conductivity of the potting compound. Toward this end two new compounds were tested, with the standard compound serving as a control. The test consisted of filling the top shields with the compound, vacuum-baking them for a minimum of two hours, and then using these filled top shields to encapsulate the devices. The transistors were given the standard preconditioning and tested to ensure electrical normalcy. Figure 3 shows the lot number and the test performed on the various lots of transistors. Compound A, which is DC-200 oil loaded with boron nitride, and Compound B, which is Dow Corning Compound DC-18, are the new compounds; Compound R is the compound now in use.

Figure 4 shows life test results to date for the lots which are undergoing 1000-hr life test. Figure 5 shows final results of the power step stress tests.

Preliminary step stress data indicate the use of Compounds A and B improves the power dissipation of the transistor, but no final conclusion can be made until the operating and storage life tests are complete.

3.6 Evaluation of Temperature-Sensitive Parameters (TSP)

During the third quarter, four methods of measuring the thermal transfer factor (θ) were investigated. The four were the standard V_{EB} method, the rapid V_{EB} method, the β method,[1] and a pulse β method.

[1] Reich, Bernard, "Continuous Transistor Thermal Resistance Measurement," Semiconductor Products, November, 1962.

FIGURE 3

TEST SETUP FOR POTTING COMPOUND EVALUATION

Lot	Compound	Test
1	A	Power step stress
2	R	Power step stress
3	A	Power step stress
4	R	Power step stress
5	A	1000 hr operating life at 120 mw
6	A	1000 hr operating life at 150 mw
7	A	1000 hr operating life at 180 mw
8	R	1000 hr operating life at 150 mw
9	B	Power step stress
10	R	Power step stress
11	B	Environmental life test
12	B	1000 hr storage life test at 100°C
13	R	1000 hr storage life test at 1000°C
14	B	1000 hr storage life test at 140°C
15	R	1000 hr storage life test at 140°C
16	B	Power step stress

Notes: (1) A and B are the new compounds being evaluated.
R is the regular compound now in use.

(2) Lot 4 served as the control lot for Lot 16.

FIGURE 4

LIFE TEST RESULTS TO DATE
ON POTTING COMPOUND EVALUATION

Lot	Compound	Number of Units	Test Condition	Status of Testing	Number of Failures
8	R	28	150 mw, OLT	350 hr	2
5	A	30	150 mw, OLT	100 hr	0
5	A	30	120 mw, OLT	250 hr	0
6	A	31	150 mw, OLT	350 hr	0
7	A	25	150 mw, OLT	100 hr	1
7	A	25	180 mw, OLT	250 hr	2
15	R	10	140°C, SLT	100 hr	0
14	B	10	140°C, SLT	100 hr	0
13	R	15	100°C, SLT	100 hr	0
12	B	19	100°C, SLT	100 hr	1

Notes: (1) OLT denotes operating life test; SLT denotes storage life test.
(2) Lots 5 and 7 were started at 150 mw; changed to 120 mw and 180 mw, respectively, after 100 hr.

FIGURE 5

RESULTS OF STEP STRESS TESTS
ON POTTING COMPOUND EVALUATION

Test Conditions	Number of Failures
Lot 1: 27 units, Compound A	
16 hr, 130 mw	0
16 hr, 160 mw	0
16 hr, 190 mw	2
16 hr, 220 mw	5
16 hr, 280 mw	4
16 hr, 280 mw	3
16 hr, 310 mw	6
Lot 2: 31 units, Compound R	
16 hr, 130 mw	0
16 hr, 160 mw	5
16 hr, 190 mw	10
16 hr, 220 mw	16
Lot 3: 23 units, Compound A	
16 hr, 130 mw	0
16 hr, 160 mw	0
16 hr, 190 mw	2
16 hr, 220 mw	3
16 hr, 250 mw	9
Lot 4: 14 units, Compound R	
16 hr, 130 mw	0
16 hr, 160 mw	0
16 hr, 190 mw	14

FIGURE 5 - page 2

RESULTS OF STEP STRESS TEST ON POTTING COMPOUND EVALUATION

Test Conditions	Number of Failures
Lot 16: 13 units, Compound B	
16 hr, 130 mw	0
16 hr, 160 mw	0
16 hr, 190 mw	0
16 hr, 220 mw	0
16 hr, 250 mw	13
Lot 9: 20 units, Compound B	
16 hr, 130 mw	0
16 hr, 130 mw	0
16 hr, 150 mw	0
16 hr, 180 mw	0
16 hr, 210 mw	2
16 hr, 240 mw	0
16 hr, 270 mw	5
Lot 10: 15 units, Compound R	
16 hr, 120 mw	0
16 hr, 150 mw	0
16 hr, 180 mw	1
16 hr, 210 mw	9
16 hr, 240 mw	3
16 hr, 270 mw	2

It was tentatively concluded that the β method appears to have an advantage in absolute accuracy over the V_{EB} method. The latter method, when used to measure jet etch transistors, gives optimistic θ values.

The rapid V_{EB} method was found to give repeatable results and is considered satisfactory for comparing transistors of the same type. Therefore, because of the speed advantage of this method, most θ measurements in this program are at present being made in this manner.

On the V_{EB} method, it was noted that changing the bias from 10 ma to 20 ma with ΔT held constant resulted in substantial changes in measured θ. Some units increased, some decreased, and others remained constant. It is thought that these changes were due to uneven distribution of current in the junction area.

Since unit reliability is affected by the resulting hot spots, and since the above four methods measure only average junction temperatures, the validity of these methods as absolute indicators of reliability is questionable. The need for life testing at various bias points remains necessary to obtain a complete reliability picture.

3.7 Punch Through Limited Transistors

At the suggestion of the U. S. Army Electronics Materiel Agency, the Sprague Electric Company has made a study of the susceptibility to transient damage of punch through limited units and diode limited units. Transistors were manufactured and subjected to an 80 V pulse. A total of 26% of the punch through limited units and 80% of the diode limited units failed thus indicating that punch through limited units are less susceptible to transient damage.

3.8 Status of Life Testing

The complete life test schedule as presented in the First Quarterly Report is repeated for convenience as Figure 6 of this report. A summary of life test results to date is presented in Figure 7. A total of 1950 units have completed the test. This amounts to 55% of the 3000 units scheduled. Another 300, comprising Lots 1B, 3B, 3G, and 6E, are still on test, and the remaining 750 are scheduled for testing later in the program.

Results to date show a marked improvement in the reliability of the unit. This can be seen in Figure 8, which is a comparison of failures experienced on initial production units with failures experienced on later production units.

LIFE TEST SCHEDULE

FIGURE 6

Type of Test / Mfg. Dates of Units	60 mw 25°C 1000 hr	60 mw 25°C 10,000 hr	75 mw 25°C 1000 hr	90 mw 25°C 1000 hr	100 mw 25°C 1000 hr	105 mw 25°C 1000 hr	120 mw 25°C 1000 hr	Step Stress Operating Life Test	Constant Stress *	85°C Storage	100°C Storage	120°C Storage	140°C Storage	θ β Method	θ V_{BE} Method	Vibration and Shock
Prior to 5/30/62	1A1-25 pcs. 1C1-50 pcs.	1B1-50 pcs.	1C2-50 pcs.	1C3-50 pcs.	1A2-25 pcs.	1C4-50 pcs.	1C5-50 pcs.	1D1-100 pcs.	1E1-100 pcs. (from 1D1)							
5/30/62 - 6/30/62	2A1-25 pcs.				2A2-25 pcs.											
6/30/62 - 7/30/62	3A1-25 pcs. 3C1-50 pcs.	3B1-50 pcs.	3C2-50 pcs.	3C3-50 pcs.	3A2-25 pcs.	3C4-50 pcs.	3C5-50 pcs.	3D1-100 pcs.	3E1-100 pcs. (from 3D1)	3F1-25 pcs.	3F2-25 pcs.	3F3-25 pcs.	3F4-25 pcs.	3G1-25 pcs.	3G2-25 pcs.	3H1-50 pcs.
7/30/62 - 8/30/62	4A1-25 pcs.				4A2-25 pcs.											
8/30/62 - 9/30/62	5A1-25 pcs.				5A2-25 pcs.											
9/30/62 - 10/30/62	6A1-25 pcs. 6C1-50 pcs.	6B1-50 pcs.	6C2-50 pcs.	6C3-50 pcs.	6A2-25 pcs.	6C4-50 pcs.	6C5-50 pcs.	6D1-100 pcs.	6E1-100 pcs. (from 6D1)							
10/30/62-11/30/62	7A1-25 pcs.				7A2-25 pcs.											
11/30/62-12/30/62	8A1-25 pcs.				8A2-25 pcs.											
12/30/62 - 1/30/63	9A1-25 pcs. 9C1-50 pcs.	9B1-50 pcs.	9C2-50 pcs.	9C3-50 pcs.	9A2-25 pcs.	9C4-50 pcs.	9C5-50 pcs.	9D1-100 pcs.	9E1-100 pcs. (from 9D1)							
1/30/63 - 2/28/63	10A1-25 pcs.				10A2-25 pcs.											
2/28/63 - 3/30/63	11A1-25 pcs.				11A2-25 pcs.											
3/30/63 - 4/30/63	12A1-25 pcs.				12A2-25 pcs.											

* Power condition in constant stress test determined by results of step stress test.

FIGURE 7

LIFE TEST RESULTS TO DATE

Lot	Number of Units	Type of Test	Status of Testing	Number of Failures
1A1*	25	60 mw, 25°C, 1000 hr	Complete	2
1A2*	25	100 mw, 25°C, 1000 hr	Complete	8
1B1*	50	60 mw, 25°C, 10,000 hr	5000 hr	9
1C1	50	60 mw, 25°C, 1000 hr	Complete	1
1C2	50	75 mw, 25°C, 1000 hr	Complete	0
1C3	50	90 mw, 25°C, 1000 hr	Complete	0
1C4	50	105 mw, 25°C, 1000 hr	Complete	1
1C5	50	120 mw, 25°C, 1000 hr	Complete	3
1D1*	100	Step stress OLT	Complete	99**
1E1*	100	Constant stress***		
2A1	25	60 mw, 25°C, 1000 hr	Complete	0
2A2	25	100 mw, 25°C, 1000 hr	Complete	0
3A1	25	60 mw, 25°C, 1000 hr	Complete	0
3A2	25	100 mw, 25°C, 1000 hr	Complete	2
3B1	50	60 mw, 25°C, 10,000 hr	2000 hr	0
3C1	50	60 mw, 25°C, 1000 hr	Complete	0
3C2	50	75 mw, 25°C, 1000 hr	Complete	0
3C3	48	90 mw, 25°C, 1000 hr	Complete	0
3C4	50	105 mw, 25°C, 1000 hr	Complete	6
3C5	48	120 mw, 25°C, 1000 hr	Complete	3
3D1	100	Step stress OLT	Complete	100**
3E1	100	Constant stress	Complete	43**
3F1	25	85°C storage	Complete	0
3F2	25	100°C storage	Complete	0
3F3	25	120°C storage	Complete	0
3F4	25	140°C storage	Complete	0
3G1	25	θ method	Units have been measured and are now on constant power step stress test.	
3G2	25	V_{EB} method		
3H1	50	Vibration and shock	Complete	0
4A1	25	60 mw, 25°C, 1000 hr	Complete	0

FIGURE 7 - page 2

LIFE TEST RESULTS TO DATE

Lot	Number of Units	Type of Test	Status of Testing	Number of Failures
4A2	25	100 mw, 25°C, 1000 hr	Complete	4
5A1	25	60 mw, 25°C, 1000 hr	Complete	0
5A2	25	100 mw, 25°C, 1000 hr	Complete	0
6A1	25	60 mw, 25°C, 1000 hr	Complete	0
6A2	25	100 mw, 25°C, 1000 hr	Complete	0
6B1	50	60 mw, 25°C, 10,000 hr	2000 hr	0
6C1	50	60 mw, 25°C, 1000 hr	Complete	0
6C2	50	75 mw, 25°C, 1000 hr	Complete	0
6C3	50	90 mw, 25°C, 1000 hr	Complete	0
6C4	50	105 mw, 25°C, 1000 hr	Complete	0
6C5	50	120 mw, 25°C, 1000 hr	Complete	1
6D1	100	Step stress OLT	Complete	99**
6E1	100	Constant stress	On test	9**
7A1	25	60 mw, 25°C, 1000 hr	Complete	0
7A2	25	100 mw, 25°C, 1000 hr	Complete	0

*Initial production units.

**Detailed results of this test are given in Figure 9.

***This test was not run because of the poor results obtained from the test on Lot 1D1.

FIGURE 8

COMPARISON OF FAILURES ON LIFE TEST

Initial Production

Test Conditions	Unit-Hours	Number of Failures	Lots	Failure Rate (%/1000 Unit-Hours)
60 mw, 25°C, 1000 hr	25,000	2	1A1	8.0
60 mw, 25°C, 5000 hr	250,000	9	1B1	3.6
100 mw, 25°C, 1000 hr	25,000	8	1A2	32.0

Later Production

Test Conditions	Unit-Hours	Number of Failures	Lots	Failure Rate (%/1000 Unit-Hours)
60 mw, 25°C, 1000 hr	275,000	1	1C1, 2A1, 3C1, 4A1, 5A1, 6A1, 6C1, 7A1	0.36
60 mw, 25°C, 2000 hr	200,000	0	3B1	<0.5
100 mw, 25°C, 1000 hr	150,000	6	2A2, 3A2, 4A2, 5A2, 6A2, 7A2	4.0

Figure 9 is a detailed comparison of the results of the step stress tests on Lots 1D1, 3D1, and 6D1. The units of Lot 1D1 were from initial production and were not treated with the special coating. Units from Lot 3D1 were from later production and received applications of this material. It can be seen that power dissipation has improved. Figure 9 also shows the results of the constant stress test on Lots 3E1 and 6E1.

Fifty units from Lots 3G1 and 3G2, which were used in the θ studies, have been placed on 150 mw operating life test to determine whether there is correlation between the value of θ and reliability. These units will be read at 48-hr intervals up to 480 hr and every 96 hr thereafter.

3.9 Technical Action Request No. 1

Technical Action Request No. 1, a request to change the case size from TO-9 to TO-18, was approved during this period.

FIGURE 9

RESULTS OF STEP STRESS AND CONSTANT STRESS TESTS

Step Stress Test

Condition	Number of Failures Lot 1D1, 100 Units	Number of Failures Lot 3D1, 100 Units	Number of Failures Lot 6D1, 100 Units
15 hr, 90 mw	1	1	0
15 hr, 105 mw	16	0	0
15 hr, 120 mw	55	0	2
15 hr, 135 mw	27	1	0
15 hr, 150 mw		4	0
15 hr, 165 mw		8	8
15 hr, 180 mw		45	33
15 hr, 195 mw		35	33
15 hr, 210 mw		6	23
Total	99	100	99

Notes: (1) One unit in Lot 1D1 ruined by testing error.
(2) One unit in Lot 6D1 had a broken lead.

Constant Stress Test (Performed at 150 mw, 25°C, 1000 Hr)

Lot	Readout Time	Unit-Hours	Total Number of Failures at Readout
3E1	768 hr	56,550	43
6E1	864 hr	86,400	9

Notes: (1) Lot 6E1 is still on test.
(2) Lot 3E1 was discontinued after 768 hr.

SECTION 4

CONCLUSIONS

(1) Manufacturing and process control specifications for the 2N1500 transistor have been written.

(2) Problems with delineation have been isolated, and work toward their solutions is progressing. It is anticipated that work on this step of the process will be completed by the end of the fourth quarter.

(3) An investigation of two new higher thermal conductivity potting compounds has been performed. Preliminary results indicate that both engender an improvement in the power dissipation of the transistor, but no final conclusion will be made until operating and storage life tests are completed.

(4) Punch through limited transistors have been shown to be less prone to transient damage than diode limited units.

(5) The estimated percentages of the overall progress on the major elements of the program are as follows:

Factor	Relative Weight	% Completion	Percentage
1. Pilot Design Optimization	20	95	19
2. Production Design Engineering	10	50	5
3. Production Line De-Bugging	10	20	2

Factor	Relative Weight	% Completion	Percentage
4. Production Run	5		
5. Interim Life Testing	30	55	16
6. Quarterly Reports	10	34	3
7. Final Determination of Reliability	10		
8. Final Report	5		
TOTALS	100		45

SECTION 5

PROGRAM FOR NEXT INTERVAL

(1) Final work on the delineation process will be performed.

(2) Study on the high thermal conductivity compounds will be completed.

(3) Any design changes which data from various tests indicate necessary will be made.

SECTION 6

CONFERENCES, PUBLICATIONS, AND REPORTS

(1) A conference between representatives of the United States Army Electronics Materiel Agency and personnel of the Sprague Electric Company took place on December 12, 1962, at the Concord, New Hampshire, plant. The purpose of this conference was to review progress made on the contract during the second quarter and to discuss the Second Quarterly Report. It was concluded that the program is proceeding on schedule.

(2) The Second Quarterly Report, covering the period, July 31, 1962 - October 31, 1962, was submitted for U. S. Army Electronics Materiel Agency approval. Approval was received, and the report was distributed per USAEMA instructions.

SECTION 7

IDENTIFICATION OF PERSONNEL

Personnel	Hours
T. Achorn	176.5
J. Ayer	26.5
D. Baker	16.5
G. Baker	4.0
K. Borque	159.0
W. Boyd	35.0
T. Cichon	20.5
E. Copeland	12.5
S. Cullen	15.5
R. Duquette	86.6
N. Edwards	30.0
R. Gagne	164.0
H. Gilmore	61.0
T. Gordon	4.2
F. Hammond	11.0
W. Hildreth	19.5
J. Krantz	19.0
G. McGown	108.2
S. Meyers	148.0
J. Oliver	324.0
R. Pasho	17.0
B. Prescott	67.6
T. Richardson	44.0
L. Ritterbush	144.0
H. Smith	48.0
R. Stevens	57.0
C. Stoneham	22.5
W. Thomas	47.0
L. Wells	32.6
TOTAL	1921.2

SECTION 8

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